

ISSN 1726-5479

SENSORS & TRANSDUCERS

2^{vol. 125}
/11



Chemical Sensors, Biosensors, Immunosensors

International Frequency Sensor Association Publishing



Editors-in-Chief: professor Sergey Y. Yurish, tel.: +34 696067716, fax: +34 93 4011989, e-mail: editor@sensorsportal.com

Editors for Western Europe

Meijer, Gerard C.M., Delft University of Technology, The Netherlands
Ferrari, Vittorio, Università di Brescia, Italy

Editor South America

Costa-Felix, Rodrigo, Inmetro, Brazil

Editor for Eastern Europe

Sachenko, Anatoly, Ternopil State Economic University, Ukraine

Editors for North America

Datskos, Panos G., Oak Ridge National Laboratory, USA
Fabien, J. Josse, Marquette University, USA
Katz, Evgeny, Clarkson University, USA

Editor for Asia

Ohyama, Shinji, Tokyo Institute of Technology, Japan

Editor for Asia-Pacific

Mukhopadhyay, Subhas, Massey University, New Zealand

Editorial Advisory Board

- Abdul Rahim, Ruzairi, Universiti Teknologi, Malaysia
Ahmad, Mohd Noor, Northern University of Engineering, Malaysia
Annamalai, Karthigeyan, National Institute of Advanced Industrial Science and Technology, Japan
Arcega, Francisco, University of Zaragoza, Spain
Arguel, Philippe, CNRS, France
Ahn, Jae-Pyoung, Korea Institute of Science and Technology, Korea
Arndt, Michael, Robert Bosch GmbH, Germany
Ascoli, Giorgio, George Mason University, USA
Atalay, Selcuk, Inonu University, Turkey
Atghiaee, Ahmad, University of Tehran, Iran
Augutis, Vyngantas, Kaunas University of Technology, Lithuania
Avachit, Patil Lalchand, North Maharashtra University, India
Ayesha, Aladdin, De Montfort University, UK
Azamimi, Azian binti Abdullah, Universiti Malaysia Perlis, Malaysia
Bahreyni, Behraad, University of Manitoba, Canada
Baliga, Shankar, B., General Motors Transnational, USA
Baoxian, Ye, Zhengzhou University, China
Barford, Lee, Agilent Laboratories, USA
Barlingay, Ravindra, RF Arrays Systems, India
Basu, Sukumar, Jadavpur University, India
Beck, Stephen, University of Sheffield, UK
Ben Bouzid, Sihem, Institut National de Recherche Scientifique, Tunisia
Benachiba, Chellali, Universitaire de Bechar, Algeria
Binnie, T. David, Napier University, UK
Bischoff, Gerlinde, Inst. Analytical Chemistry, Germany
Bodas, Dhananjay, IMTEK, Germany
Borges Carval, Nuno, Universidade de Aveiro, Portugal
Bousbia-Salah, Mounir, University of Annaba, Algeria
Bouvet, Marcel, CNRS – UPMC, France
Brudzewski, Kazimierz, Warsaw University of Technology, Poland
Cai, Chenxin, Nanjing Normal University, China
Cai, Qingyun, Hunan University, China
Campanella, Luigi, University La Sapienza, Italy
Carvalho, Vitor, Minho University, Portugal
Cecelja, Franjo, Brunel University, London, UK
Cerdà Belmonte, Judith, Imperial College London, UK
Chakrabarty, Chandan Kumar, Universiti Tenaga Nasional, Malaysia
Chakravorty, Dipankar, Association for the Cultivation of Science, India
Changhai, Ru, Harbin Engineering University, China
Chaudhari, Gajanan, Shri Shivaji Science College, India
Chavali, Murthy, N.I. Center for Higher Education, (N.I. University), India
Chen, Jiming, Zhejiang University, China
Chen, Rongshun, National Tsing Hua University, Taiwan
Cheng, Kuo-Sheng, National Cheng Kung University, Taiwan
Chiang, Jeffrey (Cheng-Ta), Industrial Technol. Research Institute, Taiwan
Chiriac, Horia, National Institute of Research and Development, Romania
Chowdhuri, Arijit, University of Delhi, India
Chung, Wen-Yaw, Chung Yuan Christian University, Taiwan
Corres, Jesus, Universidad Publica de Navarra, Spain
Cortes, Camilo A., Universidad Nacional de Colombia, Colombia
Courtois, Christian, Université de Valenciennes, France
Cusano, Andrea, University of Sannio, Italy
D'Amico, Arnaldo, Università di Tor Vergata, Italy
De Stefano, Luca, Institute for Microelectronics and Microsystem, Italy
Deshmukh, Kiran, Shri Shivaji Mahavidyalaya, Barshi, India
Dickert, Franz L., Vienna University, Austria
Dieguez, Angel, University of Barcelona, Spain
Dimitropoulos, Panos, University of Thessaly, Greece
Ding, Jianning, Jiangsu Polytechnic University, China
Djordjevic, Alexandar, City University of Hong Kong, Hong Kong
Donato, Nicola, University of Messina, Italy
Donato, Patricio, Universidad de Mar del Plata, Argentina
Dong, Feng, Tianjin University, China
Drljaca, Predrag, Intersema Sensoric SA, Switzerland
Dubey, Venketesh, Bournemouth University, UK
Enderle, Stefan, Univ. of Ulm and KTB Mechatronics GmbH, Germany
Erdem, Gursan K. Arzum, Ege University, Turkey
Erkmen, Aydan M., Middle East Technical University, Turkey
Estelle, Patrice, Insa Rennes, France
Estrada, Horacio, University of North Carolina, USA
Faiz, Adil, INSA Lyon, France
Fericean, Sorin, Balluff GmbH, Germany
Fernandes, Joana M., University of Porto, Portugal
Francioso, Luca, CNR-IMM Institute for Microelectronics and Microsystems, Italy
Francis, Laurent, University Catholique de Louvain, Belgium
Fu, Weiling, South-Western Hospital, Chongqing, China
Gaura, Elena, Coventry University, UK
Geng, Yanfeng, China University of Petroleum, China
Gole, James, Georgia Institute of Technology, USA
Gong, Hao, National University of Singapore, Singapore
Gonzalez de la Rosa, Juan Jose, University of Cadiz, Spain
Granel, Annette, Goteborg University, Sweden
Graff, Mason, The University of Texas at Arlington, USA
Guan, Shan, Eastman Kodak, USA
Guillet, Bruno, University of Caen, France
Guo, Zhen, New Jersey Institute of Technology, USA
Gupta, Narendra Kumar, Napier University, UK
Hadjiloucas, Sillas, The University of Reading, UK
Haider, Mohammad R., Sonoma State University, USA
Hashsham, Syed, Michigan State University, USA
Hasni, Abdelhafid, Bechar University, Algeria
Hernandez, Alvaro, University of Alcalá, Spain
Hernandez, Wilmar, Universidad Politécnica de Madrid, Spain
Homencovschi, Dorel, SUNY Binghamton, USA
Horstman, Tom, U.S. Automation Group, LLC, USA
Hsiai, Tzung (John), University of Southern California, USA
Huang, Jeng-Sheng, Chung Yuan Christian University, Taiwan
Huang, Star, National Tsing Hua University, Taiwan
Huang, Wei, PSG Design Center, USA
Hui, David, University of New Orleans, USA
Jaffrezic-Renault, Nicole, Ecole Centrale de Lyon, France
Jaime Calvo-Galleg, Jaime, Universidad de Salamanca, Spain
James, Daniel, Griffith University, Australia
Janting, Jakob, DELTA Danish Electronics, Denmark
Jiang, Liudi, University of Southampton, UK
Jiang, Wei, University of Virginia, USA
Jiao, Zheng, Shanghai University, China
John, Joachim, IMEC, Belgium
Kalach, Andrew, Voronezh Institute of Ministry of Interior, Russia
Kang, Moonho, Sunmoon University, Korea South
Kaniusas, Eugenijus, Vienna University of Technology, Austria
Katake, Anup, Texas A&M University, USA
Kausel, Wilfried, University of Music, Vienna, Austria
Kavasoglu, Nese, Mugla University, Turkey
Ke, Cathy, Tyndall National Institute, Ireland
Khelfaoui, Rachid, Université de Bechar, Algeria
Khan, Asif, Aligarh Muslim University, Aligarh, India
Kim, Min Young, Kyungpook National University, Korea South
Ko, Sang Choon, Electronics. and Telecom. Research Inst., Korea South
Kockar, Hakan, Balikesir University, Turkey
Kong, Ing, RMIT University, Australia
Kotulska, Malgorzata, Wroclaw University of Technology, Poland
Kratz, Henrik, Uppsala University, Sweden

Kumar, Arun, University of South Florida, USA
Kumar, Subodh, National Physical Laboratory, India
Kung, Chih-Hsien, Chang-Jung Christian University, Taiwan
Lacnjevac, Caslav, University of Belgrade, Serbia
Lay-Ekuakille, Aime, University of Lecce, Italy
Lee, Jang Myung, Pusan National University, Korea South
Lee, Jun Su, Amkor Technology, Inc. South Korea
Lei, Hua, National Starch and Chemical Company, USA
Li, Genxi, Nanjing University, China
Li, Hui, Shanghai Jiaotong University, China
Li, Xian-Fang, Central South University, China
Liang, Yuanchang, University of Washington, USA
Liawruangrath, Saisunee, Chiang Mai University, Thailand
Liew, Kim Meow, City University of Hong Kong, Hong Kong
Lin, Hermann, National Kaohsiung University, Taiwan
Lin, Paul, Cleveland State University, USA
Linderholm, Pontus, EPFL - Microsystems Laboratory, Switzerland
Liu, Aihua, University of Oklahoma, USA
Liu Changgeng, Louisiana State University, USA
Liu, Cheng-Hsien, National Tsing Hua University, Taiwan
Liu, Songqin, Southeast University, China
Lodeiro, Carlos, University of Vigo, Spain
Lorenzo, Maria Encarnacio, Universidad Autonoma de Madrid, Spain
Lukasiewicz, Jerzy Pawel, Nicholas Copernicus University, Poland
Ma, Zhanfang, Northeast Normal University, China
Majstorovic, Vidosav, University of Belgrade, Serbia
Marquez, Alfredo, Centro de Investigacion en Materiales Avanzados, Mexico
Matay, Ladislav, Slovak Academy of Sciences, Slovakia
Mathur, Prafull, National Physical Laboratory, India
Maurya, D.K., Institute of Materials Research and Engineering, Singapore
Mekid, Samir, University of Manchester, UK
Melnyk, Ivan, Photon Control Inc., Canada
Mendes, Paulo, University of Minho, Portugal
Mennell, Julie, Northumbria University, UK
Mi, Bin, Boston Scientific Corporation, USA
Minas, Graca, University of Minho, Portugal
Moghavvemi, Mahmoud, University of Malaya, Malaysia
Mohammadi, Mohammad-Reza, University of Cambridge, UK
Molina Flores, Esteban, Benemérita Universidad Autónoma de Puebla, Mexico
Moradi, Majid, University of Kerman, Iran
Morello, Rosario, University "Mediterranea" of Reggio Calabria, Italy
Mounir, Ben Ali, University of Sousse, Tunisia
Mulla, Imtiaz Sirajuddin, National Chemical Laboratory, Pune, India
Nabok, Aleksey, Sheffield Hallam University, UK
Neelamegam, Periasamy, Sastra Deemed University, India
Neshkova, Milka, Bulgarian Academy of Sciences, Bulgaria
Oberhammer, Joachim, Royal Institute of Technology, Sweden
Ould Lahoucine, Cherif, University of Guelma, Algeria
Pamidighanta, Sayanu, Bharat Electronics Limited (BEL), India
Pan, Jisheng, Institute of Materials Research & Engineering, Singapore
Park, Joon-Shik, Korea Electronics Technology Institute, Korea South
Penza, Michele, ENEA C.R., Italy
Pereira, Jose Miguel, Instituto Politecnico de Seteбал, Portugal
Petsev, Dimiter, University of New Mexico, USA
Pogacnik, Lea, University of Ljubljana, Slovenia
Post, Michael, National Research Council, Canada
Prance, Robert, University of Sussex, UK
Prasad, Ambika, Gulbarga University, India
Prateepasen, Asa, Kingmoungut's University of Technology, Thailand
Pullini, Daniele, Centro Ricerche FIAT, Italy
Pumera, Martin, National Institute for Materials Science, Japan
Radhakrishnan, S., National Chemical Laboratory, Pune, India
Rajanna, K., Indian Institute of Science, India
Ramadan, Qasem, Institute of Microelectronics, Singapore
Rao, Basuthkar, Tata Inst. of Fundametal Research, India
Raoof, Kosai, Joseph Fourier University of Grenoble, France
Reig, Candid, University of Valencia, Spain
Restivo, Maria Teresa, University of Porto, Portugal
Robert, Michel, University Henri Poincare, France
Rezazadeh, Ghader, Urmia University, Iran
Royo, Santiago, Universitat Politècnica de Catalunya, Spain
Rodriguez, Angel, Universidad Politécnica de Cataluna, Spain
Rothberg, Steve, Loughborough University, UK
Sadana, Ajit, University of Mississippi, USA
Sadeghian Marnani, Hamed, TU Delft, The Netherlands
Sandacci, Serghei, Sensor Technology Ltd., UK
Schneider, John K., Ultra-Scan Corporation, USA
Sengupta, Deepak, Advance Bio-Photonics, India
Shah, Kriyang, La Trobe University, Australia
Sapozhnikova, Ksenia, D.I.Mendeleyev Institute for Metrology, Russia
Saxena, Vibha, Bhabha Atomic Research Centre, Mumbai, India
Seif, Selemeni, Alabama A & M University, USA
Seifter, Achim, Los Alamos National Laboratory, USA
Silva Girao, Pedro, Technical University of Lisbon, Portugal
Singh, V. R., National Physical Laboratory, India
Slomovitz, Daniel, UTE, Uruguay
Smith, Martin, Open University, UK
Soleymanpour, Ahmad, Damghan Basic Science University, Iran
Somani, Prakash R., Centre for Materials for Electronics Technol., India
Srinivas, Talabattula, Indian Institute of Science, Bangalore, India
Srivastava, Arvind K., NanoSonix Inc., USA
Stefan-van Staden, Raluca-Ioana, University of Pretoria, South Africa
Sumriddetchka, Sarun, National Electronics and Computer Technology Center, Thailand
Sun, Chengliang, Polytechnic University, Hong-Kong
Sun, Dongming, Jilin University, China
Sun, Junhua, Beijing University of Aeronautics and Astronautics, China
Sun, Zhiqiang, Central South University, China
Suri, C. Raman, Institute of Microbial Technology, India
Sysoev, Victor, Saratov State Technical University, Russia
Szewczyk, Roman, Industrial Research Inst. for Automation and Measurement, Poland
Tan, Ooi Kiang, Nanyang Technological University, Singapore
Tang, Dianping, Southwest University, China
Tang, Jaw-Luen, National Chung Cheng University, Taiwan
Teker, Kasif, Frostburg State University, USA
Thirunavukkarasu, I., Manipal University Karnataka, India
Thumbavanam Pad, Kartik, Carnegie Mellon University, USA
Tian, Gui Yun, University of Newcastle, UK
Tsiantos, Vassilios, Technological Educational Institute of Kaval, Greece
Tsigara, Anna, National Hellenic Research Foundation, Greece
Twomey, Karen, University College Cork, Ireland
Valente, Antonio, University, Vila Real, - U.T.A.D., Portugal
Vanga, Raghav Rao, Summit Technology Services, Inc., USA
Vaseashta, Ashok, Marshall University, USA
Vazquez, Carmen, Carlos III University in Madrid, Spain
Vieira, Manuela, Instituto Superior de Engenharia de Lisboa, Portugal
Vigna, Benedetto, STMicroelectronics, Italy
Vrba, Radimir, Brno University of Technology, Czech Republic
Wandelt, Barbara, Technical University of Lodz, Poland
Wang, Jiangping, Xi'an Shiyou University, China
Wang, Kedong, Beihang University, China
Wang, Liang, Pacific Northwest National Laboratory, USA
Wang, Mi, University of Leeds, UK
Wang, Shinn-Fwu, Ching Yun University, Taiwan
Wang, Wei-Chih, University of Washington, USA
Wang, Wensheng, University of Pennsylvania, USA
Watson, Steven, Center for NanoSpace Technologies Inc., USA
Weiping, Yan, Dalian University of Technology, China
Wells, Stephen, Southern Company Services, USA
Wolkenberg, Andrzej, Institute of Electron Technology, Poland
Woods, R. Clive, Louisiana State University, USA
Wu, DerHo, National Pingtung Univ. of Science and Technology, Taiwan
Wu, Zhaoyang, Hunan University, China
Xiu Tao, Ge, Chuzhou University, China
Xu, Lisheng, The Chinese University of Hong Kong, Hong Kong
Xu, Sen, Drexel University, USA
Xu, Tao, University of California, Irvine, USA
Yang, Dongfang, National Research Council, Canada
Yang, Shuang-Hua, Loughborough University, UK
Yang, Wuqiang, The University of Manchester, UK
Yang, Xiaoling, University of Georgia, Athens, GA, USA
Yaping Dan, Harvard University, USA
Ymeti, Aurel, University of Twente, Netherland
Yong Zhao, Northeastern University, China
Yu, Haihu, Wuhan University of Technology, China
Yuan, Yong, Massey University, New Zealand
Yufera Garcia, Alberto, Seville University, Spain
Zakaria, Zulkarnay, University Malaysia Perlis, Malaysia
Zagnoni, Michele, University of Southampton, UK
Zamani, Cyrus, Universitat de Barcelona, Spain
Zeni, Luigi, Second University of Naples, Italy
Zhang, Minglong, Shanghai University, China
Zhang, Quintao, University of California at Berkeley, USA
Zhang, Weiping, Shanghai Jiao Tong University, China
Zhang, Wenming, Shanghai Jiao Tong University, China
Zhang, Xueji, World Precision Instruments, Inc., USA
Zhong, Haoxiang, Henan Normal University, China
Zhu, Qing, Fujifilm Dimatix, Inc., USA
Zorzano, Luis, Universidad de La Rioja, Spain
Zourob, Mohammed, University of Cambridge, UK

Contents

Volume 125
Issue 2
February 2011

www.sensorsportal.com

ISSN 1726-5479

Research Articles

Microcantilever Sensors in Biological and Chemical Detections <i>Qing Zhu</i>	1
Design of a Low Voltage 0.18 μm CMOS Surface Acoustic Wave Gas Sensor <i>M. Moghavvemi and A. Attaran</i>	22
Glucose Monitoring System Based on Osmotic Pressure Measurements <i>Alexandra Leal, António Valente, Ana Ferreira, Salviano Soares, Vitor Ribeiro, Olga Krushnitskaya, and Erik A. Johannessen</i>	30
Chemical Vapor Identification by Plasma Treated Thick Film Tin Oxide Gas Sensor Array and Pattern Recognition <i>J. K. Srivastava, Preeti Pandey, Sunil K. Jha, V. N. Mishra, R. Dwivedi</i>	42
A Preliminary Test for Skin Gas Assessment Using a Porphyrin Based Evanescent Wave Optical Fiber Sensor <i>Roman Selyanchyn, Sergiy Korposh, Wataru Yasukochi and Seung-Woo Lee</i>	54
Optical Characterization and Humidity Sensing Properties of Praseodymium Oxide <i>B. C. Yadav, Monika Singh and C. D. Dwivedi</i>	68
Nanocrystalline SnO_2-Pt Thick Film Gas Sensor for Air Pollution Applications <i>M. H. Shahrokh Abadi, M. N. Hamidon, Abdul Halim Shaari, Norhafizah Abdullah, Rahman Wagiran and Norhisam Misron</i>	76
Characterization of WO_3-SnO_2 Nanocomposites and Application in Humidity Sensing <i>N. K. Pandey, Akash Roy, Alok Kumar</i>	89
Detections of Water Content Changes in a Nitrocellulose Membrane Based on Polarized Reflection Spectroscopy <i>Hariyadi Soetedjo</i>	100
Fabrication of Polyaniline/ TiO_2 Nanocomposite Ammonia Vapor Sensor <i>S. G. Pawar, S. L. Patil, M. A. Chougule, B. T. Raut, S. A. Pawar and V. B. Patil</i>	107
Impact of Mineral Composition on the Distribution of Natural Radionuclides in Rigosol-Anthrosol <i>Z P. Tomić, A. R. Djordjević, M. B. Rajković, I. Vukašinović, N. S. Nikolić, V. Pavlović and Č. M. Lačnjevac</i>	115
Design of Photoreactor and Study of Modeling Parameters for Removal of Pesticides in Water: a Case Study of Malathion <i>Amit K. Sharma, R. K. Tiwari and M. S. Gaur</i>	131
Studies on Gas Sensing Performance of Cr-doped Indium Oxide Thick Film Sensors <i>D. N. Chavan, G. E. Patil, D. D. Kajale, V. B. Gaikwad, G. H. Jain</i>	142
Preparation and Studies on Gas Sensing Performance of Pure and Modified Sn-TiO_2 Thick Film Resistor <i>P. D. Hire, V. B. Gaikwad, N. U. Patil, R. L. Patil, R. M. Chaudhri, S. D. Shinde G. H. Jain</i>	156
Electroconductivity Studies of Grafted Polymer Thin Film	168

Muhammed Mizher Radhi 177

Ester Sensing with Poly (Aniline-co-m-aminobenzoic Acid) Deposited on Poly (Vinyl Alcohol)

S. Adhikari, J. Singh, R. Banerjee and P. Banerji 177

Fiber Bragg Grating Sensor for Detection of Nitrate Concentration in Water

A. S. Lalasangi, J. F. Akki, K.G. Manohar, T. Srinivas, P. Radhakrishnan, Sanjay Kher, N. S. Mehla and U. S. Raikar 187

Study on Gas Sensing Performance of In₂O₃ Thick Film Resistors Prepared by Screen Printing Technique

S. C. Kulkarni, R. Y. Borse 194

Periodically Tapered LPFG for Ethanol Concentration Detection in Ethanol-Gasoline Blend

J. Linesh, T. M. Libish, M. C. Bobby, P. Radhakrishnan and V. P. N. Nampoori 205

Chemically Deposited n-CuInSe₂ / Polyiodide Based PEC Solar Cells

R. H. Bari and L. A. Patil 213

Sensitivity and Selectivity Studies on Polyaniline / Molybdenum Trioxide Composites to Liquid Petroleum Gas

Aashis S. Roy, Machappa T, M. V. N. Ambika Prasad and Koppalkar R. Anilkumar 220

Long-term Biosensors for Metabolite Monitoring by using Carbon Nanotubes

Cristina Boero, Sandro Carrara, Giovanni De Micheli 229

Modeling of a Bio Sensor Based on Detection of Antigens Concentration Using an Electrically Actuated Micro Cantilever

Hadi Madinei, Ali-Asghar Keyvani-Janbahan, Mehdi Atashparva, Rasool Shabani, Ghader Rezazadeh 238

A SAW Delay Line Sensor Combined with Micro-hotplate for Bio-chemical Applications

Babak Vosoughi Lahijani, Habib Badri Ghavifekr 247

Bioelectrical Impedance Analysis Device: Measurement of Bioelectrical Tissue Conductivity in Dengue Patients

Herlina Abdul Rahim, Mohd Nasir Taib, Fatimah Ibrahim and Ruzairi Abdul Rahim 256

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Please visit journal's webpage with preparation instructions: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm>

International Frequency Sensor Association (IFSA).

Mobile Advertising Solutions for Sensor Industry:
How to reach 80,000+ addressable mobile audiences?

An industry first Smartphone mobile advertising solution for sensors manufacturers and distributors





50% OFF
for limited time interval

Create your account today and use a **discount coupon code ls10001** to start advertising your sensors now:
https://www.lesensor.com/sensor/Profiles/CreateNewAccount.aspx?sensor_portal=ls10001



The Second International Conference
on Sensor Device Technologies and Applications

SENSORDEVICES 2011

August 21-27, 2011 - French Riviera, France



Important deadlines:

Submission deadline	March 23, 2011
Notification	April 30, 2011
Registration	May 15, 2011
Camera ready	May 22, 2011

Tracks:

- Sensor devices
- Photonics
- Infrared
- Ultrasonic and Piezosensors
- Sensor device technologies
- Sensors signal conditioning and interfacing circuits
- Medical devices and sensors applications
- Sensors domain-oriented devices, technologies, and applications
- Sensor-based localization and tracking technologies

<http://www.iaria.org/conferences2011/SENSORDEVICES11.html>



The Fifth International Conference on Sensor
Technologies and Applications

SENSORCOMM 2011

August 21-27, 2011 - French Riviera, France



Important deadlines:

Submission deadline	March 23, 2011
Notification	April 30, 2011
Registration	May 15, 2011
Camera ready	May 22, 2011

Tracks:

- APASN: Architectures, protocols and algorithms of sensor networks
- MECSN: Energy, management and control of sensor networks
- RASQOFT: Resource allocation, services, QoS and fault tolerance in sensor networks
- PESMOSN: Performance, simulation and modelling of sensor networks
- SEMOSN: Security and monitoring of sensor networks
- SECSN: Sensor circuits and sensor devices
- RIWISN: Radio issues in wireless sensor networks
- SAPSN: Software, applications and programming of sensor networks
- DAIPSN: Data allocation and information in sensor networks
- DISN: Deployments and implementations of sensor networks
- UNWAT: Under water sensors and systems
- ENOPT: Energy optimization in wireless sensor networks

<http://www.iaria.org/conferences2011/SENSORCOMM11.html>



The Fourth International Conference on Advances
in Circuits, Electronics and Micro-electronics

CENICS 2011

August 21-27, 2011 - French Riviera, France



Important deadlines:

Submission deadline	March 23, 2011
Notification	April 30, 2011
Registration	May 15, 2011
Camera ready	May 22, 2011

Tracks:

- Semiconductors and applications
- Design, models and languages
- Signal processing circuits
- Arithmetic computational circuits
- Microelectronics
- Electronics technologies
- Special circuits
- Consumer electronics
- Application-oriented electronics

<http://www.iaria.org/conferences2011/CENICS11.html>

Bioelectrical Impedance Analysis Device: Measurement of Bioelectrical Tissue Conductivity in Dengue Patients

Herlina ABDUL RAHIM, Mohd Nasir TAIB, Fatimah IBRAHIM
and Ruzairi ABDUL RAHIM

Department of Control and Instrumentation Engineering, Faculty of Electrical Engineering,
Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, Malaysia

Received: 28 October 2011 /Accepted: 15 February 2011 /Published: 28 February 2011

Abstract: This paper describes and introduces a new approach to monitor dengue hemorrhagic fever using BIA technique. This technique is an *in vivo* technique where an approximately a small average constant current of 460 μA at single frequency, 50 kHz is applied through human body, and measure the body's resistance and reactance to that current via four-surface electrode. These measurements are combined with the patient data (i.e. age, sex, height and weight) to estimate mass and water compartments. The dengue's clinical studies in correlation with the BIA measurement have been conducted on 119 male and 91 female who are the DHF patients in Universiti Kebangsaan Malaysia, Hospital (HUKM) in Malaysia. The data obtained show that it is possible to predict a patient's condition; recovering or leading to hemorrhagic by monitoring the increasing trend of phase angle and reactance and the decreasing trend for the of ratio of extracellular to intracellular water (ECW/ICW) and ratio of extracellular body mass to body cell mass (ECM/BCM). Experimental findings show that bioelectrical tissue conductivity (BETC), as reflected by reactance is the key determinant indicator for monitoring the hemoglobin status in the DHF patients. Hence, this novel approach of BIA technique can provide rapid, non-invasive, and promising method for monitoring and evaluating the status of the DHF patients. *Copyright © 2011 IFSA.*

Keywords: Dengue fever, Dengue haemorrhagic fever, Haematological profile, Bioelectrical tissue conductivity, and bioelectrical impedance analysis device.

1. Introduction

Dengue fever (DF) ranks highly among the newly emerging infectious diseases in public health significance. Hence it is considered to be the most important arthropod-borne viral diseases. In

Malaysia, the disease is endemic but major outbreaks seem to occur at least once in every four years [1]. Dengue fever was first reported in Malaysia after an epidemic in Penang in 1902 [2, 3]. Since the early 1970s, the World Health Organization (WHO) has been actively involved in the developing and promoting strategies for treatment and control of dengue. In 1997, WHO published a second guide to the diagnosis, treatment and control of dengue haemorrhagic fever [4]. Dengue were reported throughout the year and started to increase from 1997 to 1998. In 1998, 27,373 dengue cases with 58 deaths were reported as compared to 19,544 cases with 50 deaths in 1997. This has shown an increase of 7,829 cases or 40.1 % over the number of cases in 1997 [5].

Dengue is a tropical viral infection, which affects hematological system. Thrombocytopenia and haemoconcentration (an increase in the hemotocrit of 20 % or more) representing the pathophysiological hallmarks of abnormal hemostatis and plasma leakage, respectively, are constant findings. Plasma leakages can lead to shock, which if uncorrected lead to tissue anoxia, metabolic acidosis and death.

Narayanan *et. al.* [6] noticed a higher proportion of tourniquet test positivity among children with shock. This also corroborates the finding by Bethell *et. al.* [7] regarding to the increased proportion of skin bleeding in patients with shock. They also investigation findings showed that platelet counts were significantly lesser in patients who developed shock. Bleeding has a correlation to platelet count only when it is less than 50,000/cu.mm. Balasubramanian *et. al.* [8] showed a haematocrit value of 34.8 % in children less than 5 years and 37.5 % in more than 5 years of age, good predictive indicators for haemo concentration in DHF.

This paper investigated that all descriptive analysis of haematological profile showed that constant abnormalities occur in PLT, AST, and ALT, while HCT only has a moderate elevation.

2. Experimental Set-up

Human body can be represented as consisting of resistances and capacitances. In a healthy living body, the cell membrane consists of a layer of non-conductive lipid material sandwiched between two layers of conductive protein molecules. Biologically, the cell membrane functions as a permeable barrier separating the intracellular (cytoplasm) and extracellular components (Fig. 1a). It is traversed by numerous water soluble proteins, thus producing pores through which water, ions and other chemicals can enter and exit the cell. Controlling the flow of these materials is essential to life. The cell membrane protects the interior of the cell while allowing passage of some materials to which it is permeable.

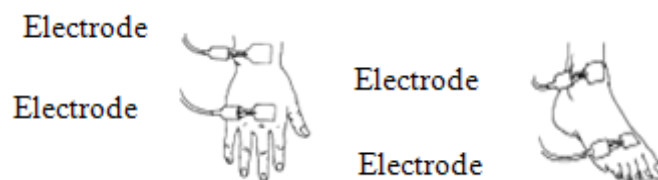


Fig. 1. Electrodes placement on the right side of the wrist and ankle. Electrodes A and B are current sources while electrodes C and D are voltage pick-up [17].

The cell membrane is composed mostly of a double layer of phospholipids, arranged tail to tail along the width of the cell membrane. This structure is called the lipid bilayer and is an electrical insulator (dielectric), as all fats and oils are. The head of the phospholipids are polar (carry a charge) and the

tails are non-polar. The heads interact with water, where the tail is repulsed by water aligning them tail to tail with the heads facing the outside and inside of the cell.

In this study, the BIA measurement were conducted by way of a tetrapolar configuration [12] using the BIA 450 analyzer. The four electrode technique used by this system largely avoids the aforementioned difficulties faced when using the two electrode technique. Four surface electrodes are used: two electrodes were placed on the subject's right hand, one at the base of knuckles and another slightly above the wrist joint. Another two electrodes were placed on the right foot, one near the base of the toes and the other slightly above the ankle joint.

The BIA 450 analyzer delivers constant current less than 1 mA at 50 kHz into the tissue via the electrodes attached at base of the knuckles and base of the toes (current electrodes between points A and B) and the signal was picked up by the other two sensor electrodes (voltage electrodes between points C and D) slightly above the ankle and wrist joints as shown in Fig. 1.

Ibrahim *et. al.* [14] describes a model for predicting haemoglobin (Hb) by using BIA in dengue patients. In this developed model, four predictors were found to be the best predictive factors for modeling Hb in dengue patients. Haematocrit (Hct) and Hb (Hct is a approximately 3Hb [15] are related to each other, and Ibrahim *et. al.* [14] has shown that Hct was not suitable for modeling DF and DHF patients, thus Hb was chosen. BIA was sensitive in determining the hydration profile in dengue patients.

2.1. Data Collection

The data were obtained from the previous work [16]. For the first group, the severity of the DHF is classified into grade I to IV, according to WHO recommendation [17]. Acute dengue infection was confirmed subsequently by the use of ELISA to detect elevated dengue specific IgM (primary infection) and IgG (secondary infection) [18]. Patient serum samples were tested for hemoglobin determination using an automated counter (Coulter STKS machine).

The second group is the control group for healthy female and male subjects. The second group of patients (control subjects) who do not have past medical history of dengue were recruited and studied using the same guidelines as in the BIA subject preparation used for the first group [16]. The BIA safety measurements procedure and other safety precautions were made known to the subjects and their informed consent was obtained from each subject prior to the BIA measurement.

For the control subject, the weight was taken only once throughout the whole study. However for subjects with dengue infection, the weight was measured daily until upon discharged.

2.2. Clinical Experiments

One of the clinical methods in making dengue diagnosis is to establish the clinical history-taking, physical examination and investigation. Each patient undergoes detailed history taking, physical examinations and blood investigations following their admission. Clinical evaluations and haematological investigations are conducted continuously until they are discharged.

The patients were also admitted at different stages of their illness, thus it is important to have the results of clinical signs and symptoms, blood investigations, and other analyses dated with a consistent and proper reference point [16]. Nevertheless, thorough documentation of symptoms and blood

investigations do not offer definitive advantage in the management and monitoring of dengue cases. A more useful measure is to develop a complete day-to-day profile of clinical manifestations and blood investigations made according to a proper reference point based on the 'Fever day' definition [16]. This is to ensure that the data used in the analysis will refer to a common reference point, regardless of how many days of fever the patient has experienced.

2.3. BIA Experiments

The bioelectrical impedance experiments are conducted using the bioimpedance analyzer. It is important to note that there is no historical or clinical evidence that bioimpedance testing is unsafe, even for pregnant women or persons with pre-existing heart conditions.

During the years 2001 and 2002, two hundred and ten adult patients aged twelve years old and above, with serological confirmation (WHO 1997) of acute dengue infection, admitted in HUKM, Malaysia were prospectively studied. At present, the knowledge acquisition to present pattern to classify the dengue infections is limited to the clinical symptoms and signs. Thus, only clinical symptoms were used as the input data for classify the dengue infections.

A total of one hundred and forty two volunteers with no past medical history were recruited and studied as the control subjects. For the control subject the weight was taken once, however for subjects with dengue infection the weight was measured daily until upon discharged.

The statistical analysis was performed using SPSS statistical package version 10.01 for Window 1998. Simple linear regression was used in the preliminary analysis for testing the significance of the variables. These variables were then included in the multivariate analysis. Multiple linear regression was used to analyze the control effects of the patient demographic and symptom variables and BIA parameters on Hb. The model was constructed in three steps as follows:

- a. When correlation exists between variables, one or more variables were excluded for the multivariate analysis.
- b. The demographic variables were first included in the model. Once the demographic predictors were identified, add in the BIA parameters and find, which of these parameters were important predictors.
- c. The last step was to include symptom and find out whether with the addition of this predictor will make further significant contribution or not.

The last step was to include the symptom and find out whether with the addition of this predictor will make further significant contribution or not.

Only five variables are highly significant which gender, weight, reactance (X_c), vomiting and day of fever [14, 16, 19, 20].

3. Results Analysis

3.1. Data Analysis

This section presents the analysis of data collection that consists of two data groups' data which the first group is dengue data and second group is the control data.

3.1.1. Dengue Data

During the year 2001 to 2002, two hundred and ten adult patients aged 12 to 83 years old, suspected of DF and DHF admitted to the Universiti Kebangsaan Malaysia Hospital (HUKM), were monitored. The dengue infection was also confirmed serologically by detection of IgM antibody using the ELISA method. For all the 210 dengue patients studied, 119 (56.7 %) were male and 91 (43.3 %) were female. Distributions are shown in the majority of the confirmed patients were Malays (116 or 55.2 %), followed by Chinese with 60 patients (28.6 %), Indian with 15 (7.1 %) and others with 19 (9.0 %). Except for the Indians, the majority of patients were male. The female to male ratio for the Malay, Chinese, and Others was 0.8, 0.8, and 0.3 respectively.

The proportion of those who had DHF II is much higher (53.3 %) than DHF I (43.3 %), followed by DF (2.8 %) and DSS (0.5 %). The length of hospital stay duration ranged from 3 to 18 days, with an average of 5.3 days.

The sample size of the female was more than the male for DF by 4 patients. However, for DHF I the males exceeded the females by 11; the males increased by 22 compared to females in DHF II and there was only one female DSS patient. In the age distribution analysis, the patient majority were mainly in the 15-24 years group age (35.71 %), followed by the 25-34 years group age (25.24 %). Those aged between 35-44 years constituted 20 % for all cases. This indicates that the majority of the patients were teenagers and young adults, whom were more likely to be involved in outdoor activities and thus more likely to be exposed to the danger of dengue infection.

3.1.2. Demographic Data and Symptoms Analysis

The sample of 210 dengue patients consisted of 119 males and 91 females. The results indicate that almost (80 %) patients experienced anorexia on the day of admission, followed by petechial rash (55.7 %), nausea (35.7 %), body ache (34.8 %), headache (30.0 %) and others.

All patients had consistent symptoms with DF, which included abrupt onset of severe anorexia, petechial rash, nausea, body ache, headache, arthralgia, weakness in lower limb, dizziness and fainting, myalgia, macular and vomiting.

In the early stage, patients with DHF had similar symptoms to those with DF, but after several days the patients became irritable and gradually developed bleedings in a number of sites on their body, including gum bleeding, petechial rash (appears as pinpoint spots under the skin), and ecchymoses (confluent bleeding under the skin). DHF II is much more serious than DHF I with extra bleeding manifestations, including blood stained saliva and ecchymoses.

3.1.3. Bioelectrical Impedance Analysis

In the analysis of bioelectrical tissue conductivity (BETC) parameters for the healthy subjects, it was found that body capacitance (BC) and phase angle (α) were lower in the female subjects compared to their male counterparts (Table 2). On the other hand, resistor (R) and reactance (X_c) were higher in females than in males. A similar trend for the BETC parameters was also observed in dengue patients, where a higher α and BC values were found in males, and a higher R and X_c values were found in females. For example, on 'Fever day 0', the mean α for male was $6.69 \pm 0.91^\circ$ and female was $5.45 \pm 1.02^\circ$, while the mean BC was 821.24 ± 187.58 pF and 516.82 ± 112.93 pF for males and females, respectively. However, the female R ($592.14 \pm 93.90 \Omega$) and X_c ($56.92 \pm 15.73 \Omega$) were higher than the male R ($462.77 \pm 76.81 \Omega$) and X_c ($54.02 \pm 11.15 \Omega$), respectively (Table 2).

3.1.3.1. Control Data

The healthy control data, a total of 144 volunteers with no past medical history were analyzed. The patients were between the ages of 13 to 60 years old, and 53 (37 %) were males and 91 (63 %) were females. The majority of the confirmed patients were Malays (95 or 66.0 %), followed by Chinese with 36 patients (25.0 %), Indian with 3 (2.0 %) and others with 10 (7.0 %).

In the age distribution analysis, the majority were mainly in the 15-24 years group age (35.71 %), followed by the 25-34 years group age (25.24 %). Those aged between 35-44 years constituted 20 % for all races.

3.1.3.2. Bioelectrical Impedance Analysis

Mean values of BETC descriptive analysis for both female and male dengue patients were always lower than the values for normal.

3.1.3.3. Experiment I for SPSS

Correlations between variables were analyzed using Spearman's correlation coefficient. It is a standardized measure of the strength of the relationship between two variables that does not rely on the assumptions of a parametric test. A matrix is displayed by giving the correlation coefficient between the two variables such as gender and height (0.647), underneath is the significant values of the coefficient (0.000) and finally the sample size (210). The significant value for this correlation coefficient is less than 0.05. Therefore, it can be concluded that there is a significant relationship between the gender and height.

Linear regression was used to identify the most significant variable among the bioelectrical impedance analysis parameters. The significant variables were resistance and reactance ($p < 0.05$). Table 1 shows the model parameters. This model includes nine variables predicting the Hb, but only four variables are highly significant.

Table 1. Significant parameters for 210 dengue patients on day-of-admission.

Model	Coefficients (a)				
	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
(Constant)	6.012	3.75		1.603	0.112
GENDER	1.309	0.551	0.338	2.373	0.02
RISK	-0.241	0.32	-0.063	-0.753	0.453
HEIGHT	0.020	0.025	0.096	0.82	0.414
RACE	0.066	0.177	0.031	0.375	0.709
WEIGHT	0.029	0.014	0.264	2.059	0.042
RESISTANCE	-0.002	0.004	-0.105	-0.514	0.609
REACTANCE	0.047	0.019	0.327	2.48	0.015
VOMITING	1.178	0.493	0.191	2.388	0.019
ANOREXIA	0.156	0.341	0.035	0.458	0.648

a. Dependent Variable: Hemoglobin

The best model produced by the multilinear regression using four variables (gender, weight, reactance and vomiting) only yields an accuracy of 43 %. This model can be written as follows:

$$Hb = 6.012 + 1.309(\text{gender}) + 0.029(\text{weight}) + 0.047(\text{reactance}) + 0.19(\text{vomiting}) + \varepsilon \quad (1)$$

Where gender = 0 for female and 1 for male; *weight* is the weight of patients in kg; *react.* Is the reactance of patients in Ohm; vomiting = 1 for sign of vomit and 0 for no sign of vomit; ε is the error term.

3.1.3.4. Validation of Experiment 1 for Statistical Analysis

The actual Hb values were compared with the Hb model obtained as can be seen in Table 2. The calculated values from the Hb model match very well with the actual Hb values obtained from the blood sample. For example, a female patient with reactance of 77.70 Ω , weight of 38.00 kg and with sign of vomit had Hb of 12.30 g/dl based on her blood sample, *c.f.* 12.31 g/dl evaluated by the model. Case number 15, female patient with reactance of 52.90 Ω , weight of 70.00 kg and with no sign of vomit had Hb of 12.70 g/dl based on her blood sample, *c.f.* 12.56 g/dl evaluated by this model. Another example for male patient with reactance of 57.50 Ω , weight of 54.00 kg and with no sign of vomit had his Hb measured at 14.00 g/dl, *c.f.* 13.97 g/dl when evaluated using the Hb model. For case number 199, with reactance of 50.20 Ω , weight of 76.00 kg and with sign of vomit had Hb of 16.50 g/dl based on her blood sample, *c.f.* 15.22 g/dl evaluated by this model.

Table 2. Comparison between actual and predicted hemoglobin according to gender.

Case number	Gender	Weight (kg)	Reactance (Ω)	Vomiting	Actual hemoglobin (g/dl)	Predicted Hemoglobin (g/dl)	Residual (g/dl)
2	Female	38	77.70	1	12.30	12.31	0.01
15	Female	70	52.90	0	12.70	12.56	0.14
194	Male	54	57.50	0	14.00	13.97	0.03
199	Male	76	50.20	1	16.50	15.22	1.28

4. Conclusion

In general, this research has successfully completed the experiments for modeling a non-invasive hemoglobin model using BIA parameters and physiological data to monitor the progression of dengue infections.

Using multivariate analysis, it was found that the work presented has successfully modeled the hemoglobin status by using selected physiological parameters such as gender, vomiting, weight and day of fever incorporate with and the BIA parameters, the body reactance.

The best model produced by the multilinear regression using four variables (gender, weight, reactance and vomiting). This model can be written as follow:

$$Hb = 6.012 + 1.309(\text{gender}) + 0.029(\text{weight}) + 0.047(\text{react.}) + 0.19(\text{vomiting}) + \varepsilon$$

Acknowledgement

The author would like to Universiti Teknologi Malaysia for provide the facilities for her research.

References

- [1]. U. G. Kyle, I. Bosaeus, A. D. De Lorenzo, P. Deurenberg, M. Elia, J. M. Gomez, B. L. Heitmann, L. Kent-Smith, J. Melchior, M. Pirlich, H. Scharfetter, A. M. W. J. Schols and C. Pichard, Bioelectrical impedance analysis - part1:review of principles and methods, *Clinical Nutrition*, Vol. 23, 2004, pp. 1226-1243.
- [2]. F. M. Skae, Dengue fever in Penang, *Br. Med. J.*, Vol. 2, 1902, pp. 1581-1582.
- [3]. S. C. Gordon, Dengue: an introduction. In: Rudnick A, Lim TW, Eds. Dengue Fever Studies in Malaysia Institute for Medical Research Malaysia, *Bulletion*, Vol. 23, 1986, pp. 1-5.
- [4]. W. H. Organization, Dengue Haemorrhagic fever Diagnosis, treatment, Prevention, and control, 2nd ed. *WHO*, Geneva, 1997.
- [5]. W. C. a. R. Annual Report, Dengue Haemorrhagic Fever, Dept. of Medical Microbiology, Fac. of Medicine, *University of Malaya*, 1998.
- [6]. N. Narayanan, M. A. Aravind, P. Ambikapathy, R. Prema, and M. P. Jeyapaul, Dengue fever-Clinical and laboratory parameters associated with complications, *Dengue Bulletin*, Vol. 27, 2003, pp. 108-115.
- [7]. D. B. Bethell, J. Gamble, P. P. Loc, N. M. Dung, T. T. H. Chau, H. T. Loan, T. T. Thuy, D. T. H. Tam, I. B. Gartside, N. J. White, and N. P. J. Day, Noninvasive measurement of microvascular leakage in patients with dengue hemorrhagic fever, *Clin. Infect. Dis.*, Vol. 32, 2001, pp. 243-253.
- [8]. S. Balasubramanian, K. Anandnathan, S. Shivabalan, M. Dutta, and E. Amalraj, Cut-off haematocrit value for haemoconcentration in dengue haemorrhagic fever, *J. Trop. Pediatr*, Vol. 50, 2004, pp. 123-124.
- [9]. D. H. Libraty, T. P. Endy, S. Kalayanarooj, W. Chansiriwongs, A. Nisalak, S. Green, F. A. Ennis, and A. L. Rothman, Assessment of body fluid compartment volumes by multifrequency bioelectrical impedance spectroscopy in children with dengue, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, Vol. 96, pp. 295-299, 2002.
- [10]. Y. H. Huang, C. C. Liu, S. T. Wang, H. Y. Lei, H. S. Liu, Y. S. Lin, H. L. Wu, and T. M. Yeh, Activation of coagulation and fibrinolysis during dengue infection, *Med. Virol.*, Vol. 63, 2001, pp. 247-251.
- [11]. E. C. Van-Gorp, C. Suharti, A. T. Mairuhu, W. M. Dolmans, V. J. Ven-Der, P. N. Demacker, and J. W. Ven-Der-Meer, Changes in the plasma lipid profile as potential predictor of clinical outcome in dengue hemorrhagic fever, *Clin. Infect. Dis.*, Vol. 34, 2002, pp. 1150-1153.
- [12]. H. C. Lukaski, W. W. Bolonchuk, C. B. Hall and W. A. Siders, Validation of tetrapolar bioelectrical impedance method to assess human body composition, *Journal of Applied Physiology*, Vol. 60, No. 4, 1986, pp. 1327-1332.
- [13]. J. F. Siler, M. W. Hall and A. Hitchens, Dengue, its history, epidemiology, mechanism of transmission, etiology, clinical manifestations, immunity and prevention, *Philipp. J. Sci*, Vol. 29, 1926, pp. 1-304.
- [14]. F. Ibrahim, N. A. Ismail, M. N. Taib and W. A. B. Wan Abas, Modeling of hemoglobin in dengue fever and dengue hemorrhagic fever using bioelectrical impedance, *Physiol. Meas.*, Vol. 25, 2004, pp. 607-615.
- [15]. R. E. Berhman, and R. M. Kliegman, Nelson Essentials of Pediatrics, 4th edition, *WB Saunders Company*, Philadelphia, 2002, pp. 610.
- [16]. F. Ibrahim, Prognosis of dengue fever and dengue haemorrhagic fever using bioelectrical impedance, Ph. D. dissertation, Department of Biomedical Engineering, *University of Malaya*, July, 2005.
- [17]. Dengue Haemorrhagic fever Diagnosis, treatment, Prevention, and control, 2nd ed., *World Health Organization*, Geneva, 1997.
- [18]. E. Chungue, J. P. Boutin, and J. Roux, Antibody capture ELISA for IgM antibody titration in sera for dengue serodiagnosis and surveillance, *Research in Virology*, Vol. 140, 1989, pp. 229-240.
- [19]. A. R. Herlina, I. Fatimah, and T. Mohd Nasir, A non-invasive system for predicting hemoglobin (Hb) in dengue fever (DF) and dengue hemorrhagic fever (DHF), in *Proc. Int. Conf. on Sensor and New Techniques in Pharmaceutical and Biomedical Research (ASIASENSE)*, Kuala Lumpur, 2005.
- [20]. H. Abdul Rahim, F. Ibrahim, and M. N. Taib, Modelling of hemoglobin in dengue infection application, *Journal of Electrical Engineering (ELEKTRIKA)*, Vol. 8, 2006, pp. 64-67.

IMU & high performance inertial MEMS 2011

IFSA offers
a SPECIAL PRICE

Complete review of inertial sensors market 2009-2015

This report not only describes the market at the player and application level, but it provides a global view of the IMU market allowing the report user to build diversification strategies taking into account technical requirements.

http://www.sensorsportal.com/HTML/IMU_Markets.htm



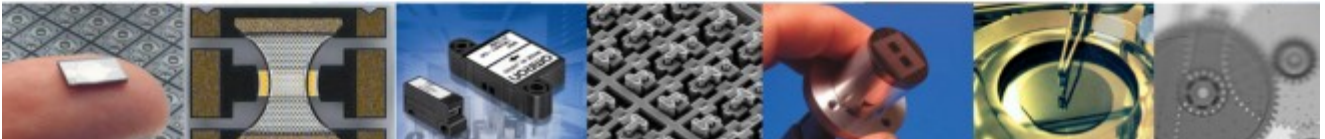
Status of the MEMS Industry

IFSA offers
a SPECIAL PRICE

MEMS device markets and key industry changes and trends

«Status of the MEMS industry 2010» is providing a unique 360° analysis of the evolutions of the MEMS applications and markets, with updated data on MEMS markets, analysis of the evolution of the industry from the manufacturing and innovation points of views, analysis of the strategies of the main players... For the 7th consecutive year, «Status of the MEMS industry» is the only publication which is analyzing the MEMS industry and its evolution, from key technical aspects to business strategies of the TOP30 MEMS companies.

http://www.sensorsportal.com/HTML/Status_of_MEMS_Industry.htm



MEMS & Sensors for Smartphones

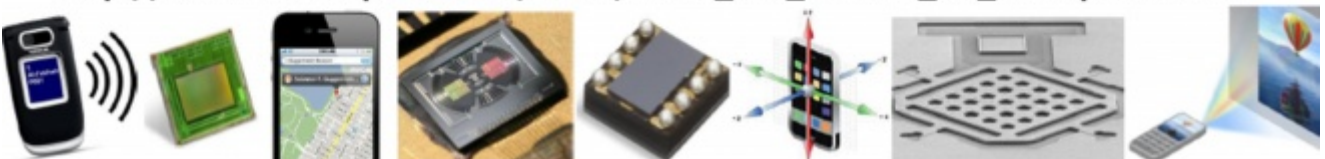
TECHNOLOGY & MARKET REPORT - JULY 2010

IFSA offers
a SPECIAL PRICE

Report provides:

- market data on MEMS & sensors for mobile phones: key market metrics & dynamics
- application focus on key sensors that are changing the mobile phone industry: new features, technical roadmap, insight about future technology trends & challenges
- a deep understanding of MEMS & sensors value chain, infrastructure & players for the handset business

http://www.sensorsportal.com/HTML/MEMS_and_Sensors_for_smartphones.htm





ABOUT THE CONFERENCE - AIM AND SCOPE

The European Conference on Organized Films 2011 is the 12th conference in a series of conferences devoted to current developments and progress in the field of thin organic films and nano-structures. It aims at promoting the understanding of films technologies, organization, and properties. It covers a wide range of subjects from fundamental research to applications. This includes material research and synthesis of organic molecules, polymers or hybrid materials with specific properties, the fabrication of thin films and nano-assemblies from Langmuir monolayers to highly organized multilayers and architectures or biomimetic systems, their patterning, and the study of the resulting structural, optical, electrical properties. Wide range of applications of thin films and nanostructures expanded the subject of the conference by including other subjects and advanced technologies such as organic and molecular electronics, photonics, photovoltaics, sensorics, biosensing and biomimetics. The ECOF 12 invites contributions that discuss these different aspects of thin films in science and technology and thus offers enormous opportunities for an intense exchange of new ideas and experiences. Welcome to Sheffield!

TOPICS

Structure

- Langmuir monolayers, LB and LS multilayers
- Self-assembly and self-organized systems
- Multilayer architectures
- Nanostructures and nanofabricated films
- Organic / inorganic hybrid systems
- Lithography and nanopatterning

Properties

- Optical and non-linear optical properties
- Electrical and magnetic properties
- Mechanical properties, rheology
- Transport phenomena

Applications

- Organic materials and polymers for electronics, molecular electronics
- Photovoltaics, photonics, sensorics
- Holography, surface patterning
- Biological and biomimetic applications

<http://www.shu.ac.uk/ad/conference21/ecof12/>

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because of it is a peer reviewed international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per year by International Frequency Sensor Association (IFSA). In addition, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc. Since 2011 the journal is covered and indexed (including a Scopus, Embase, Engineering Village and Reaxys) in Elsevier products.

Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

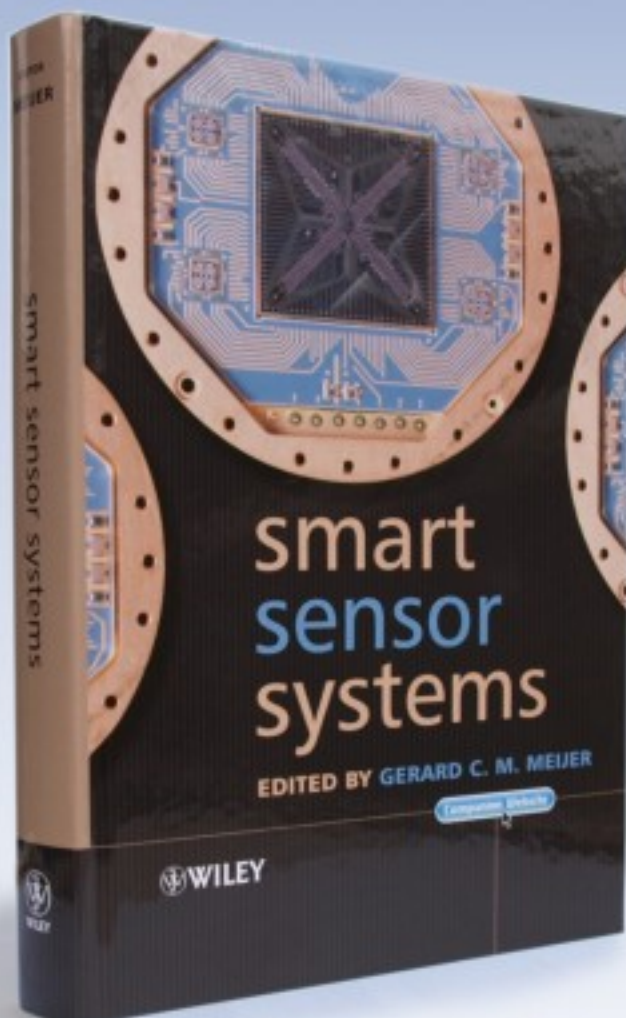
- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Submission of papers

Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 8-14 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm> Authors must follow the instructions strictly when submitting their manuscripts.

Advertising Information

Advertising orders and enquires may be sent to sales@sensorsportal.com Please download also our media kit: http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2011.pdf



'Written by an internationally-recognized team of experts, this book reviews recent developments in the field of smart sensors systems, providing complete coverage of all important systems aspects. It takes a multidisciplinary approach to the understanding, design and use of smart sensor systems, their building blocks and methods of signal processing.'



Order online:

http://www.sensorsportal.com/HTML/BOOKSTORE/Smart_Sensor_Systems.htm

www.sensorsportal.com